The CARD Experiment:

Fluid Shifts, Vasodilatation and Ambulatory Blood Pressure Reduction during Long Duration Spaceflight

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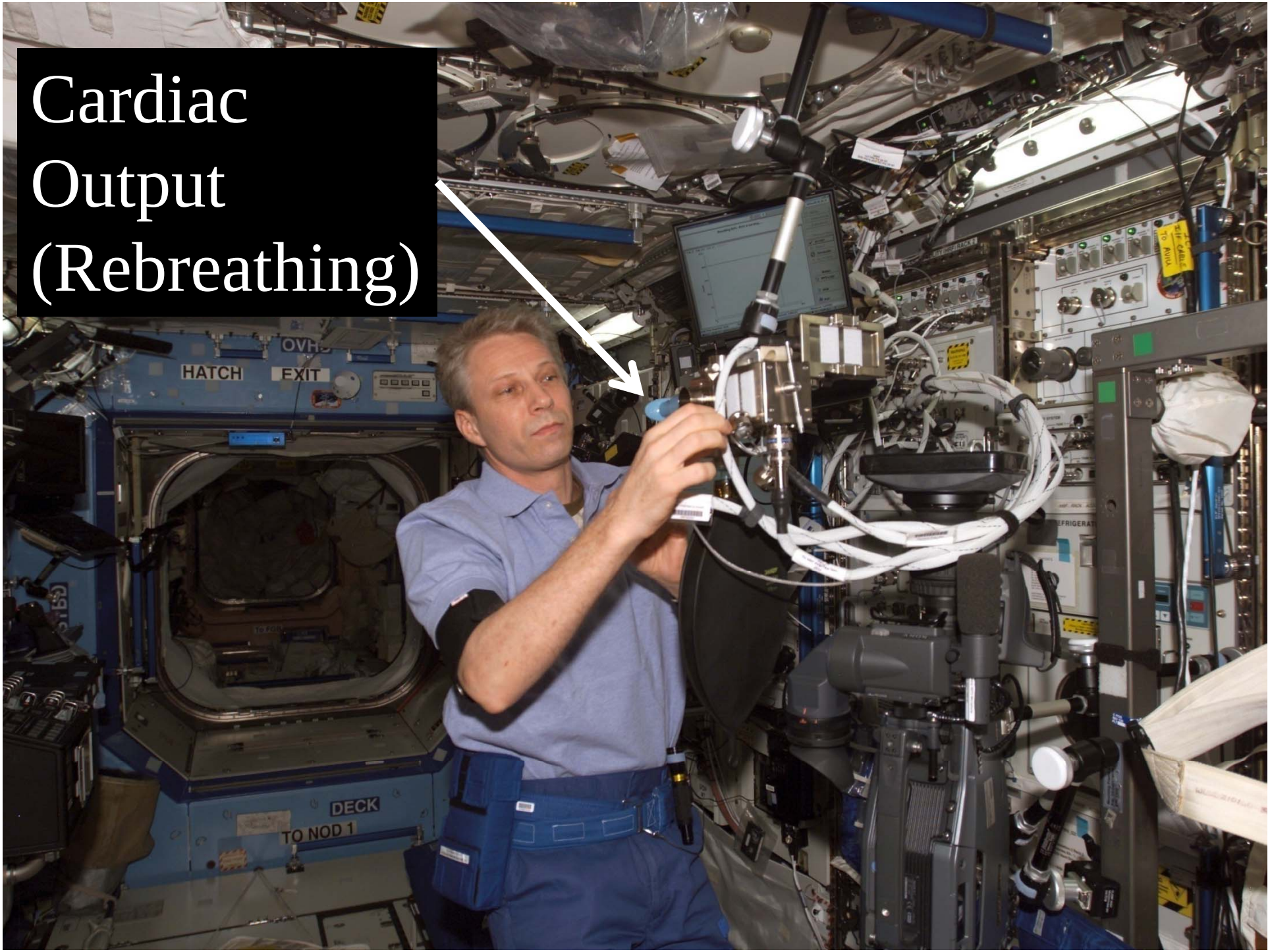
European Space Agency astronaut

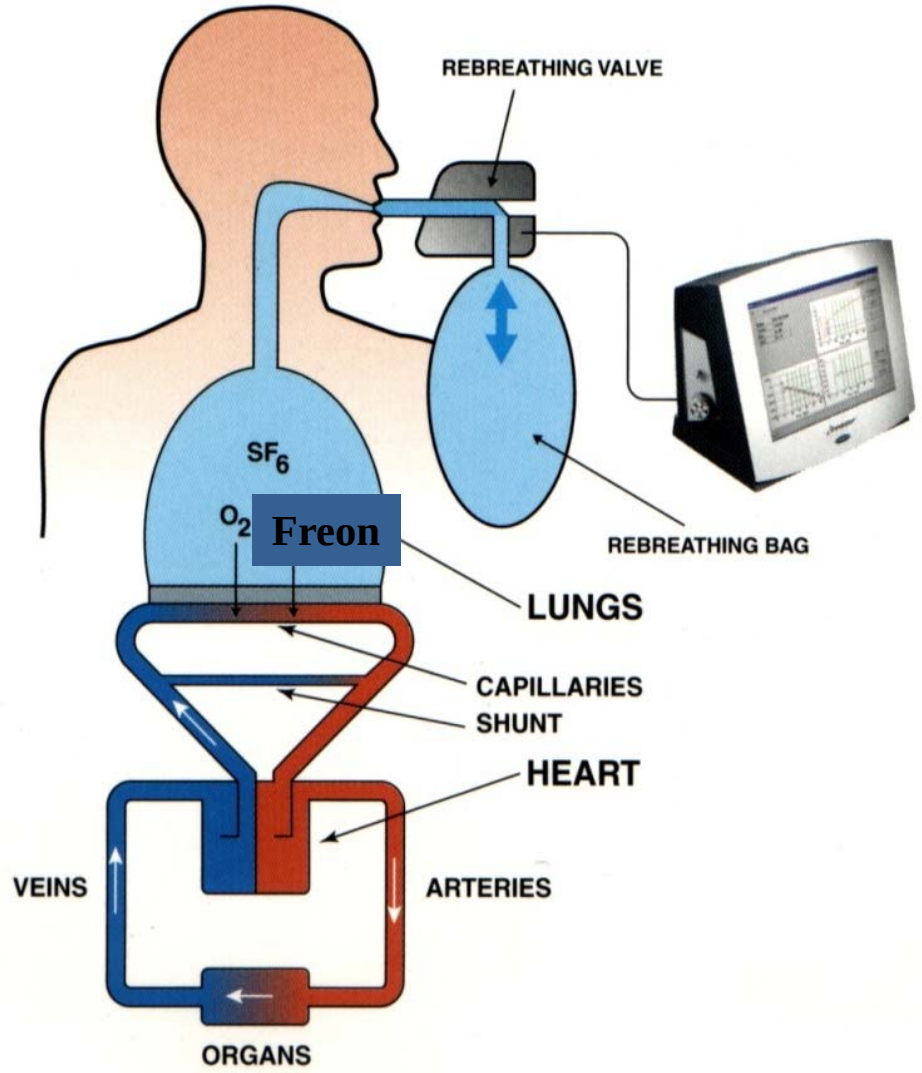
Purpose

To investigate how fluid shifts, blood pressure and systemic vascular resistance adapt to long duration (3-6 months) spaceflight.

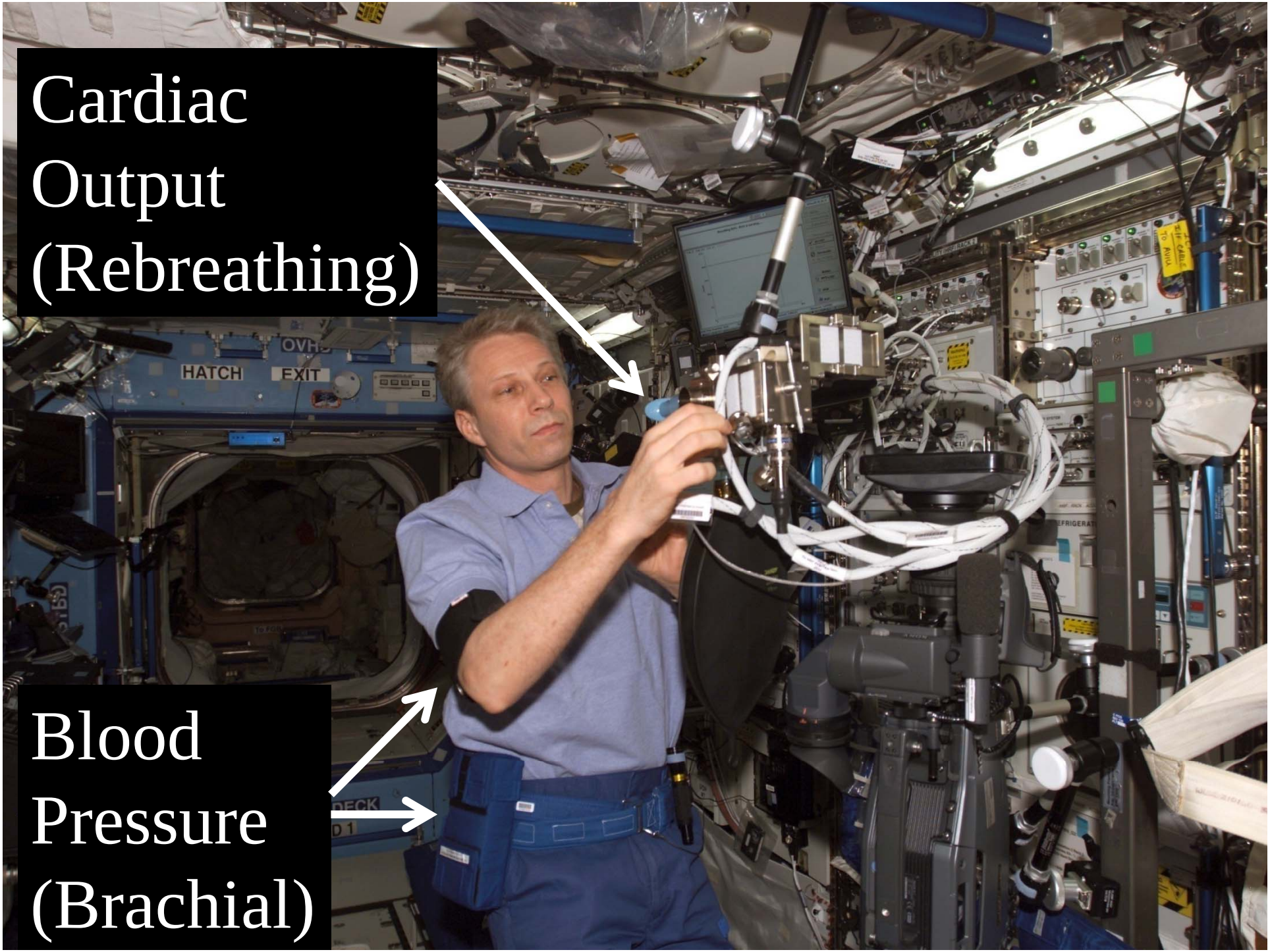
Based on results from one week into a shuttle mission (Norsk et al., Hypertension, 47: 69-73,2006)

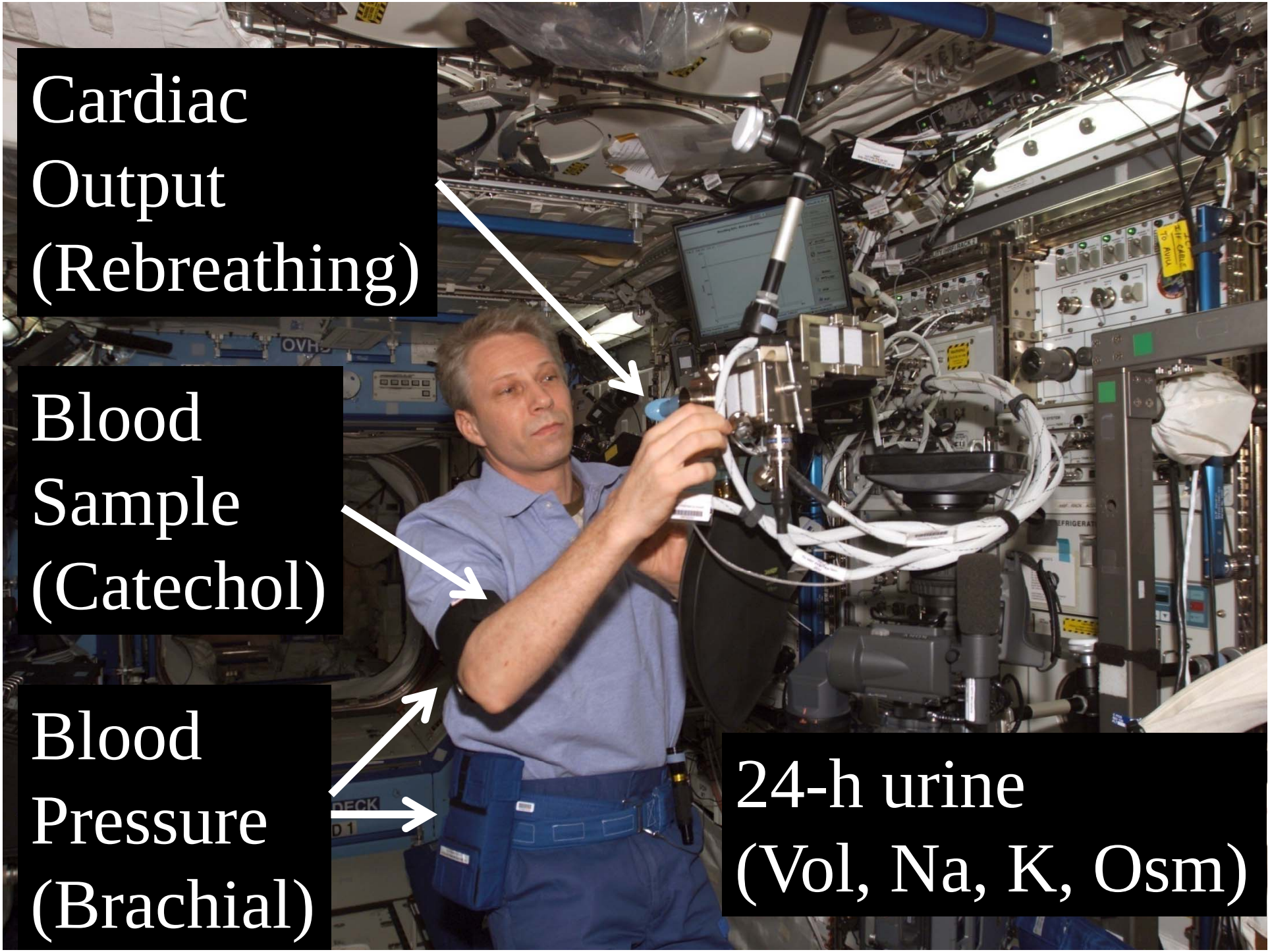

HATCH
EXIT
DECK
TO NOD 1


Cardiac
Output
(Rebreathing)
HATCH
EXIT
DECK
TO NOD 1



Cardiac output
by
rebreathing


Cardiac Output (Rebreathing)
Blood Pressure (Brachial)
HATCH
EXIT


Cardiac Output (Rebreathing)
Blood Sample (Catechol)
Blood Pressure (Brachial)
24-h urine (Vol, Na, K, Osm)

Experimental protocol

Pre-flight: Launch minus 322 – 71 days
In-flight: Launch plus 85 – 192 days in-flight
Post-flight: Landing plus 58 – 209 days

Time:	**12:00**	**14:00**	**16:00**	**18:00**	**20:00**	**22:00**	**24:00**	**02:00**	**04:00**	**06:00**	**08:00**	**10:00**	**12:00**
Blood pressure: (Ambulatory)	X	X	X	X	X	X	X	X	X	X	X	X	X
Cardiac output: (Seated)	X		X		X						X		X
Blood sampling: (Seated)											X		
Urine collection: (ambulatory)	>----------												-----<

X: Execution.

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Blood pressure: (Ambulatory)	X	X	X	X	X	X	X	X	X	X	X	X	X
Cardiac output: (Seated)	X		X		X						X		X
Blood sampling: (Seated)											X		
Urine collection: (ambulatory)	>----------												-----<

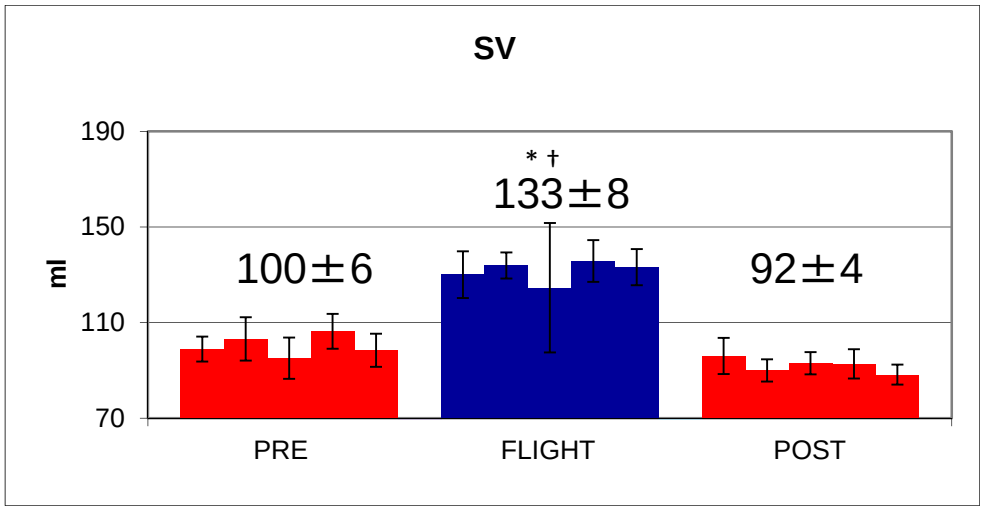
X: Execution

Results

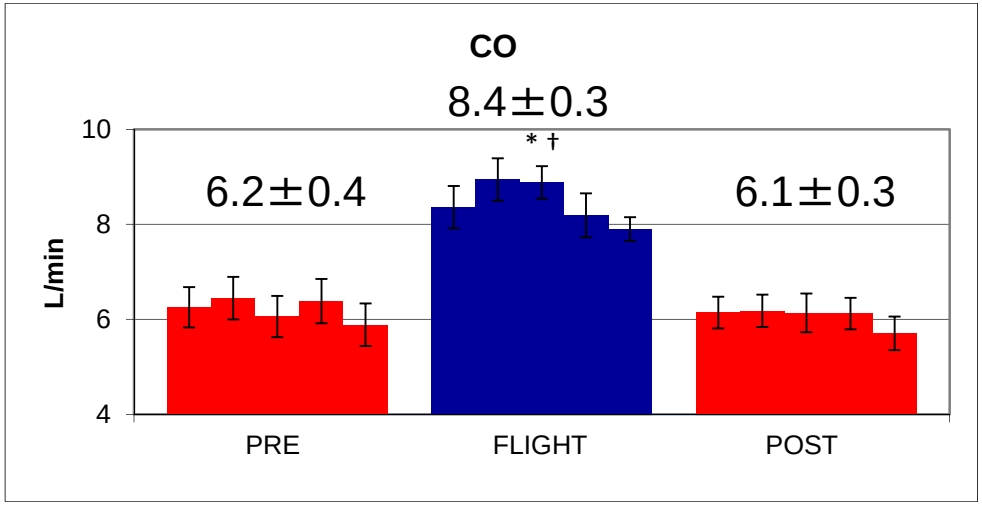
N = 8 males:

Age:	**49 ± 1 y**
Height:	**181 ± 2 cm**
Weight:	**85 ± 4 kg**

Fluid Shifts

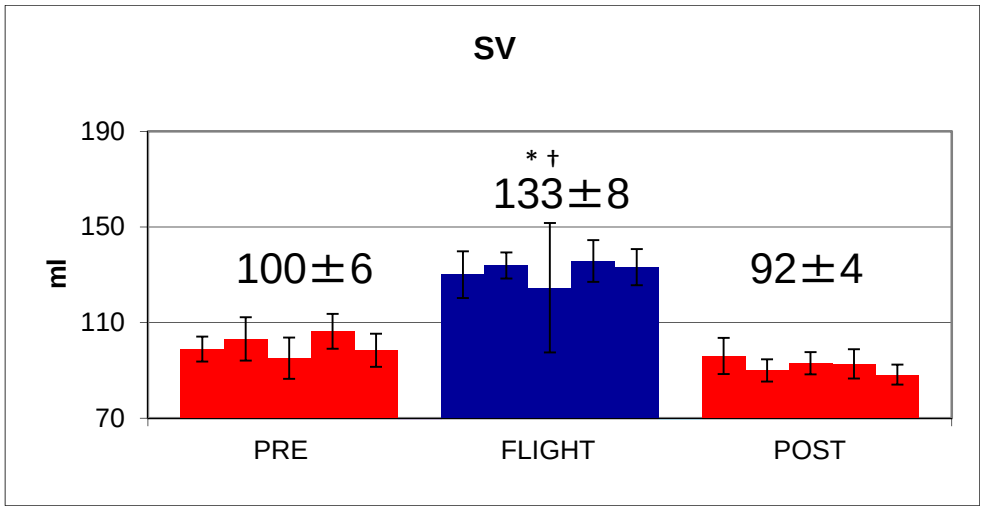


Stroke volume



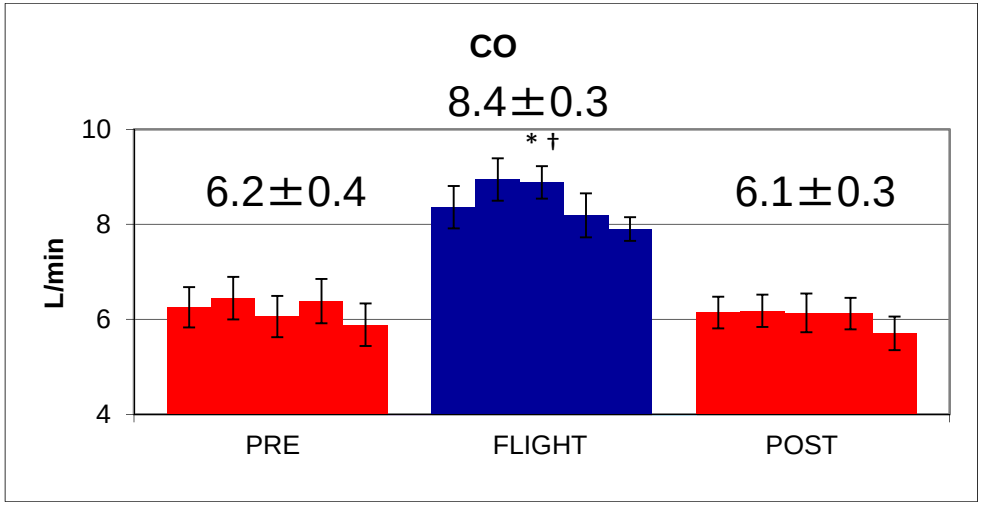
Cardiac output

Fluid Shifts



Stroke volume

35 ± 10% increase

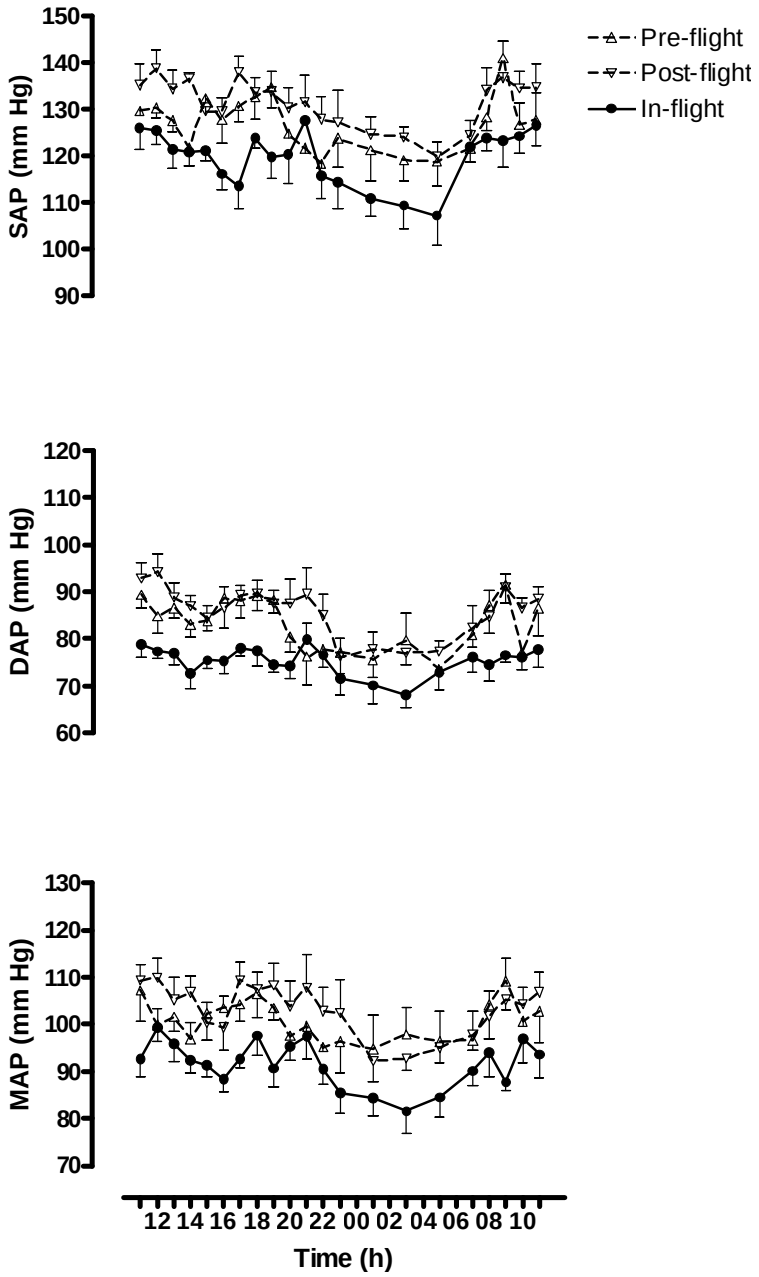


Cardiac output

41 ± 9 % increase

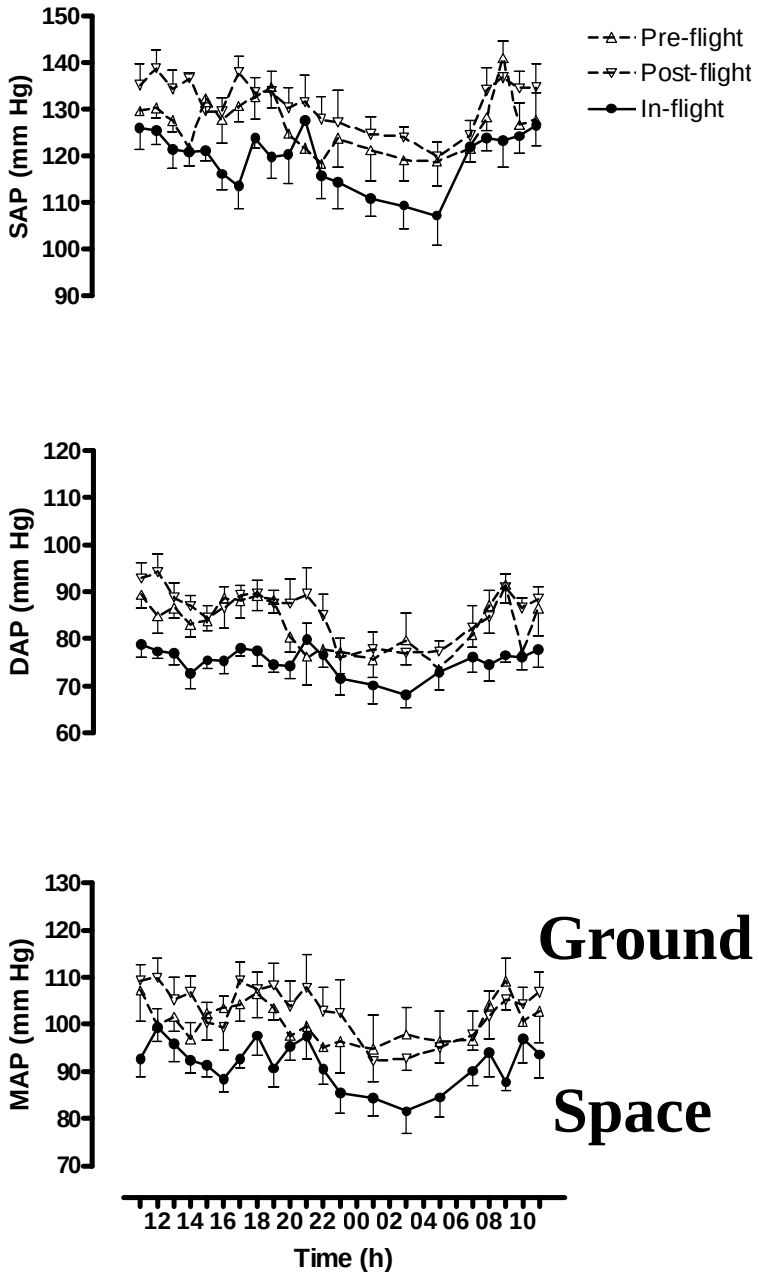
Blood Pressure

(24-h ambulatory brachial)



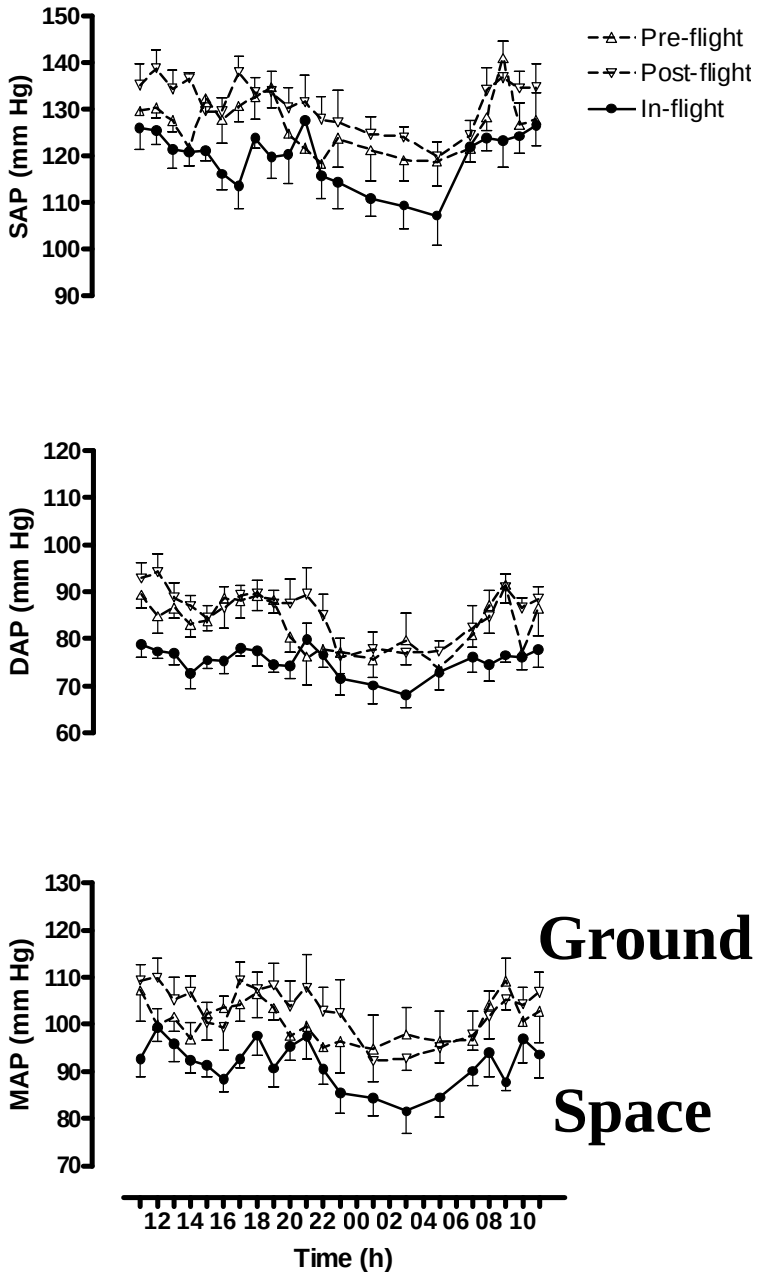
Blood Pressure

(24-h ambulatory brachial)



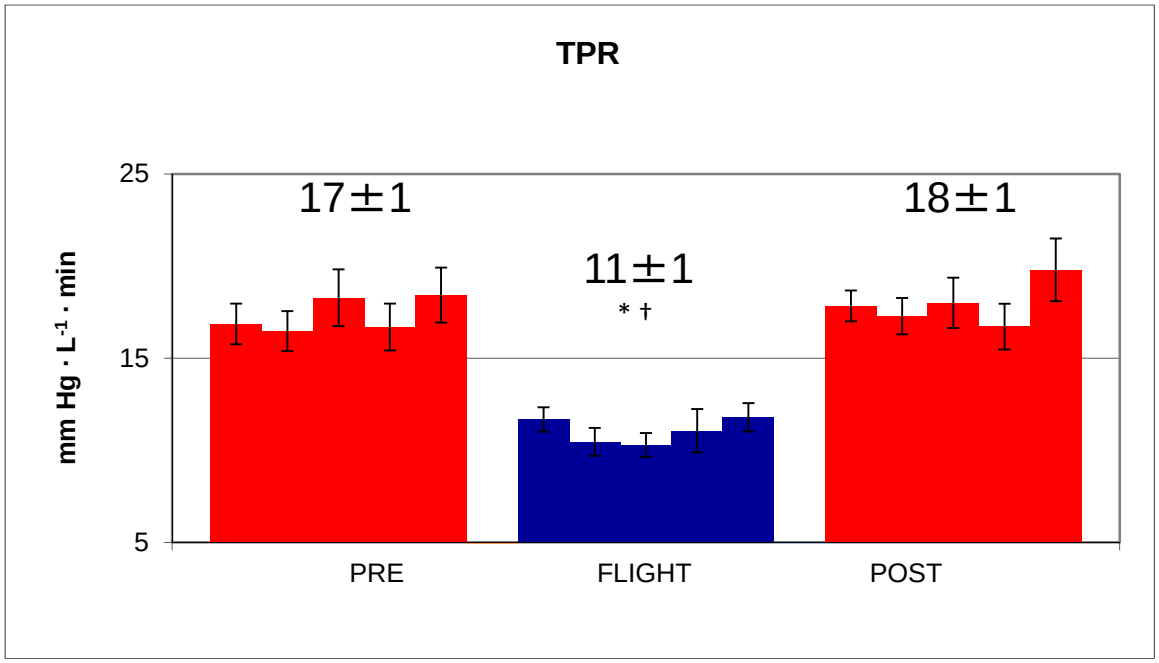
Blood Pressure

(24-h ambulatory brachial)

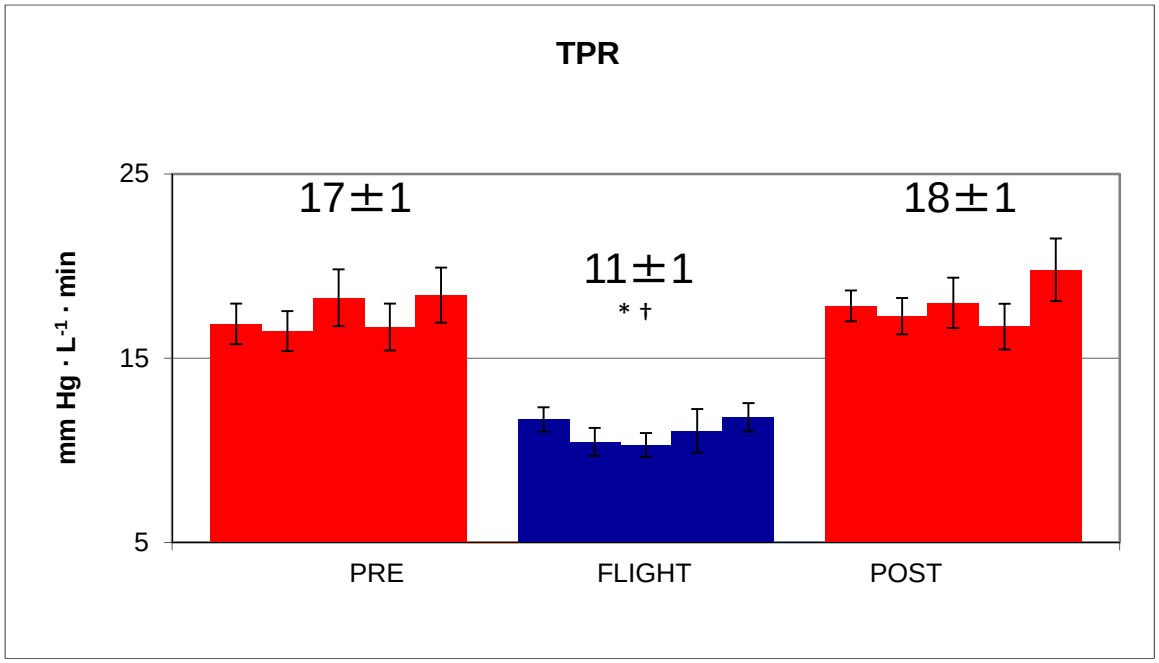


- 10 mm Hg decrease
- No change in heart rate
- Nightly dip maintained

Systemic Vascular Resistance



Systemic Vascular Resistance

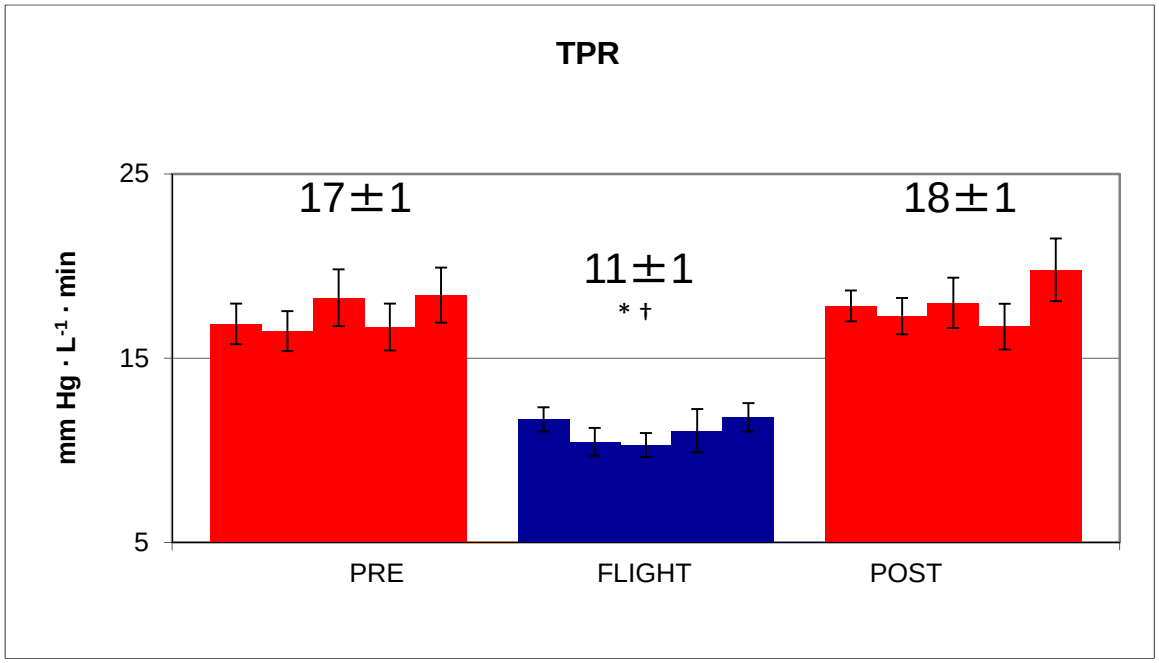


39 ± 4 % decrease

Systemic Vascular Resistance

Plasma noradrenaline (ng/l):

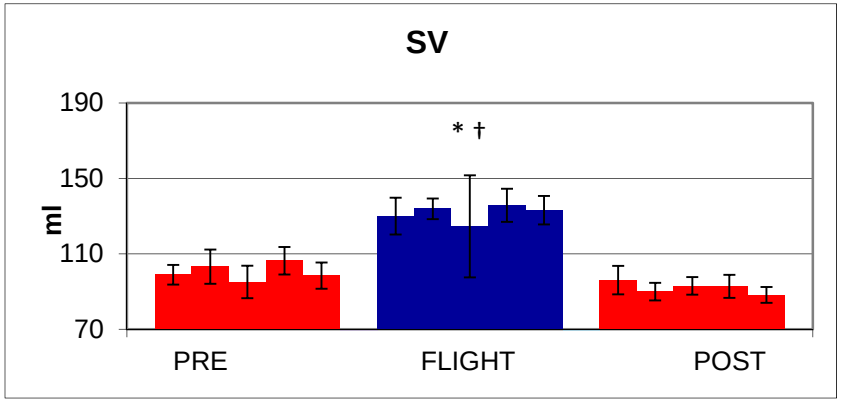
730 ± 130 720 ± 90 730 ± 100



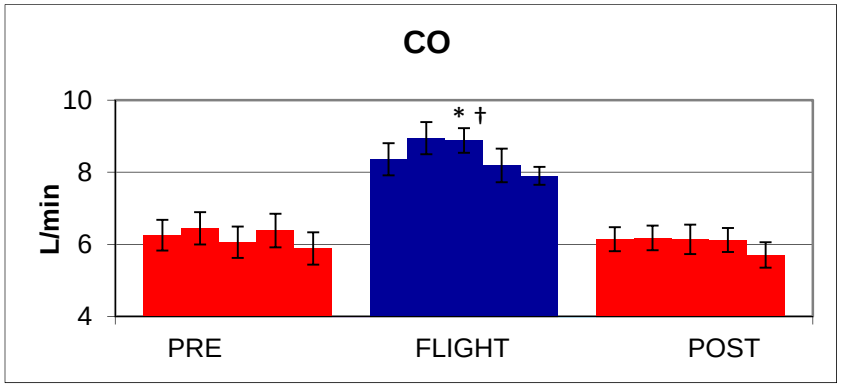
39 ± 4 % decrease

Future challenge (I):

To relate stroke volume and cardiac output to VIIP!



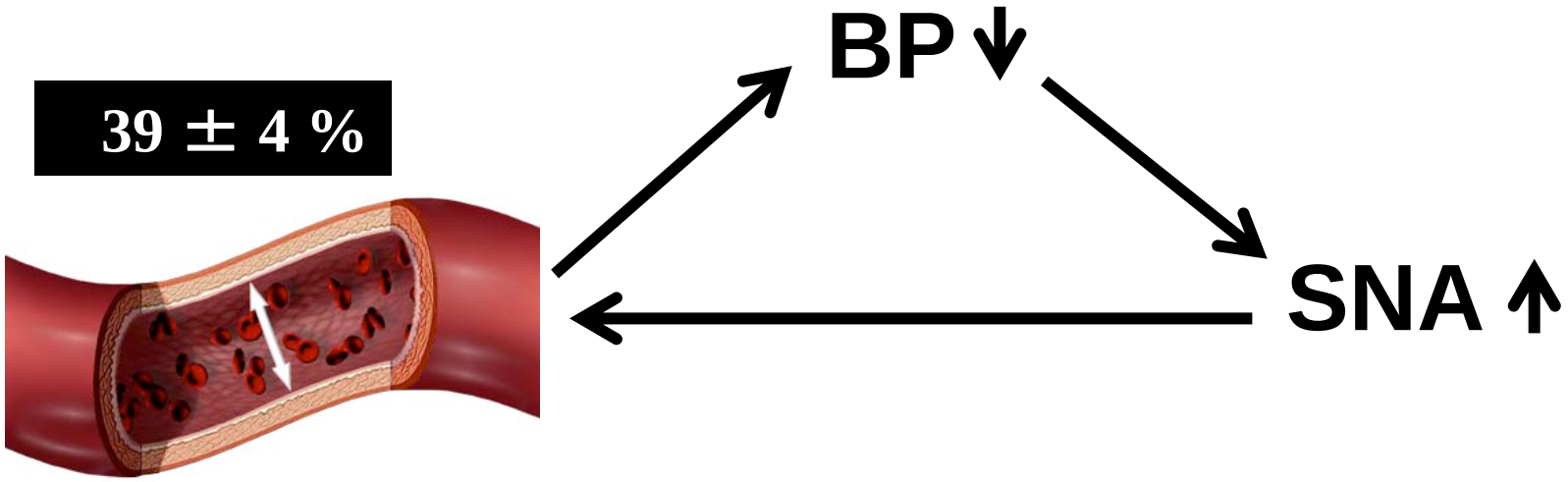
35 ± 10



41 ± 9

Future challenge (II):

To identify the spaceflight vasodilatation mechanism



Acknowledgements:

Co-authors

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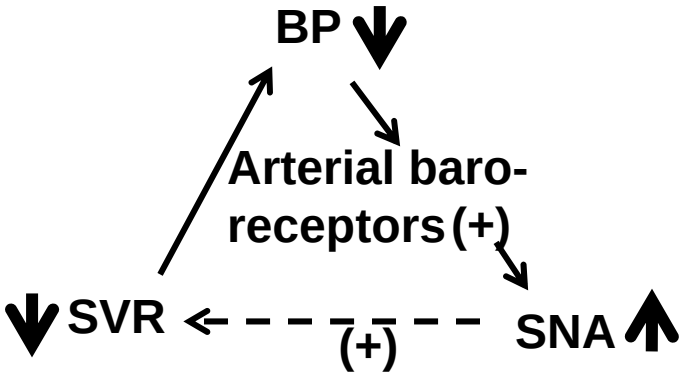
Astronauts (NASA-JSC)

Norsk et al. J. Physiol. 593: 573-584, 2015.

Thank you!

Spaceflight Vasodilatation Mechanism(s)?



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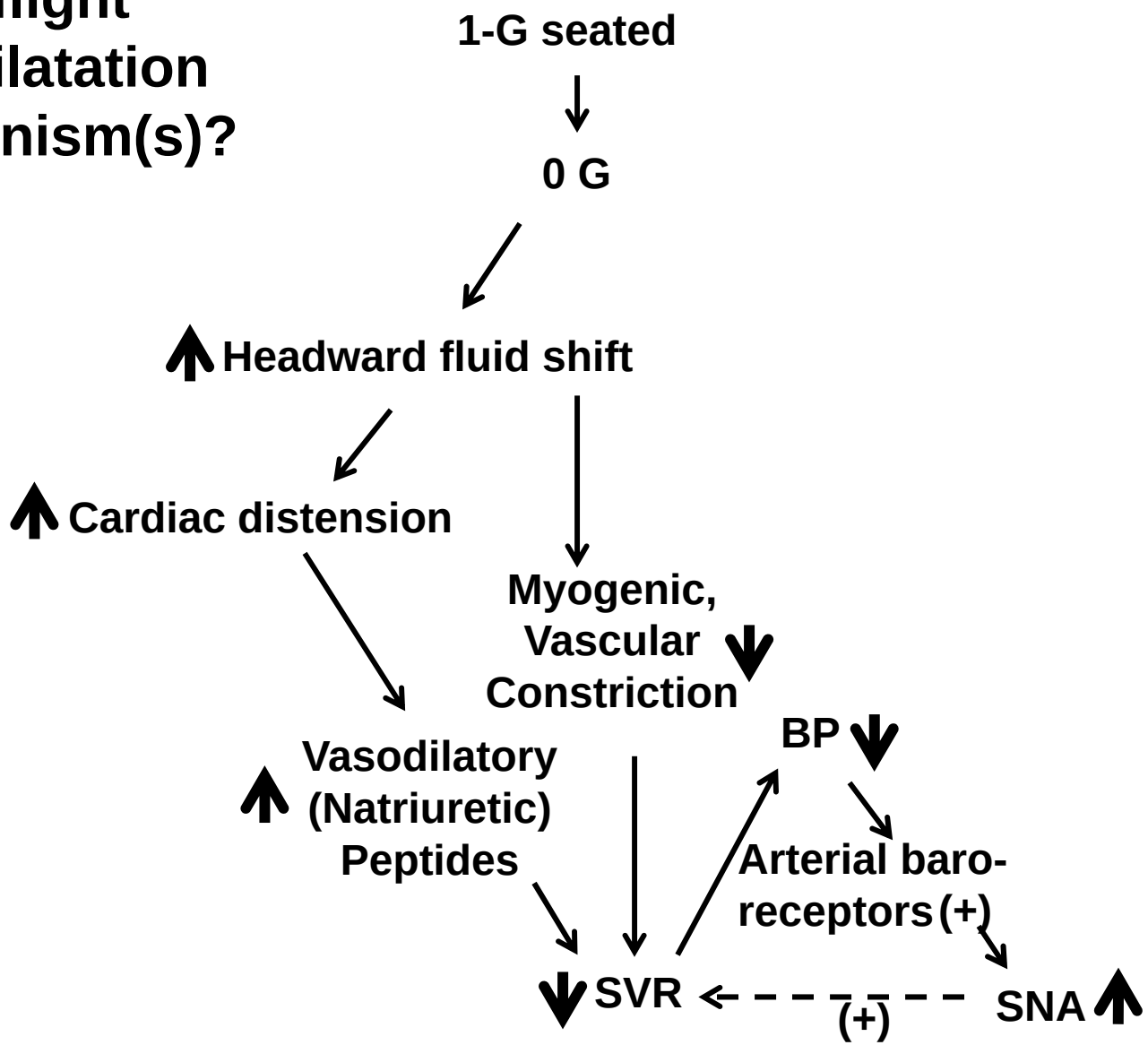

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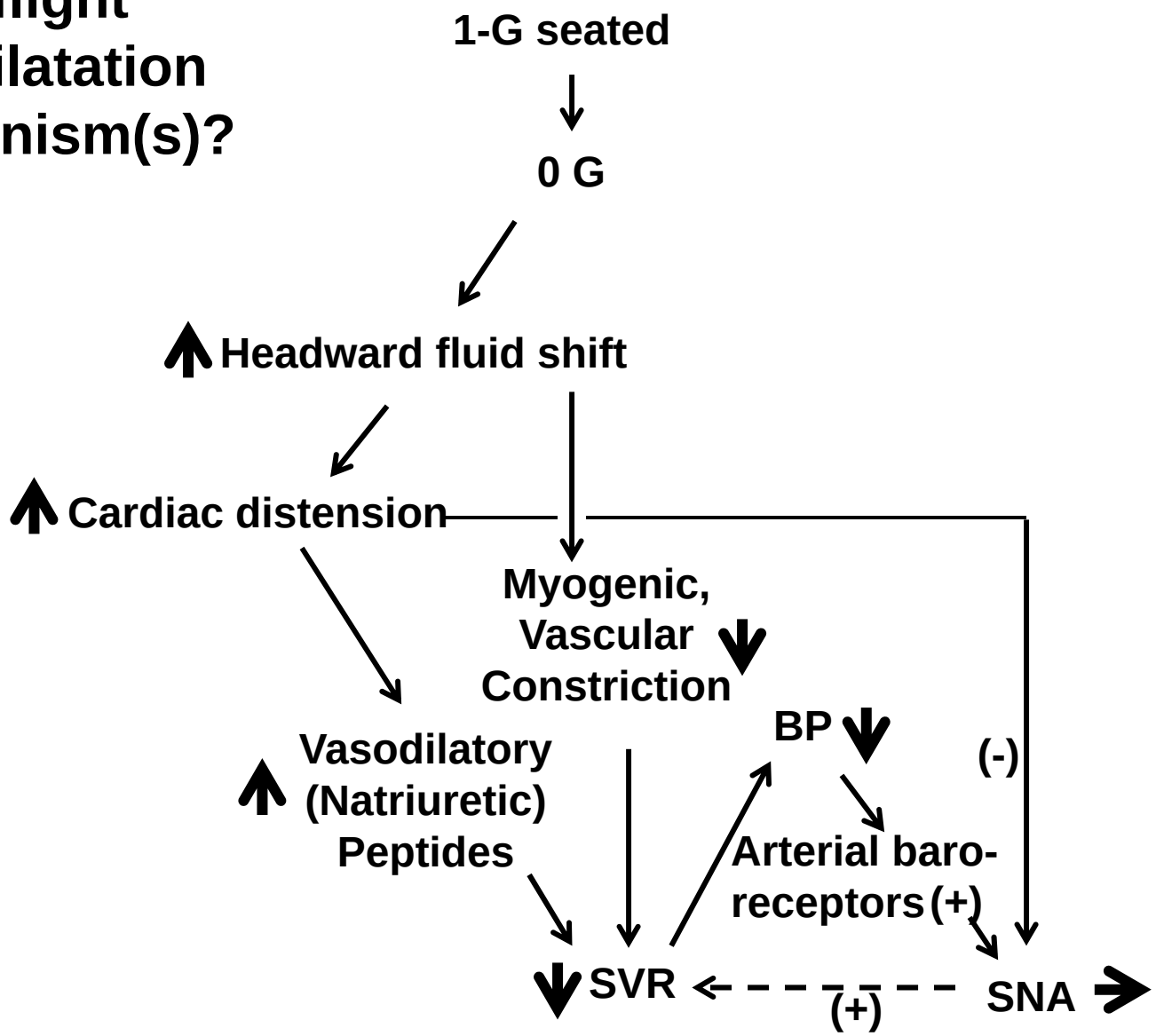
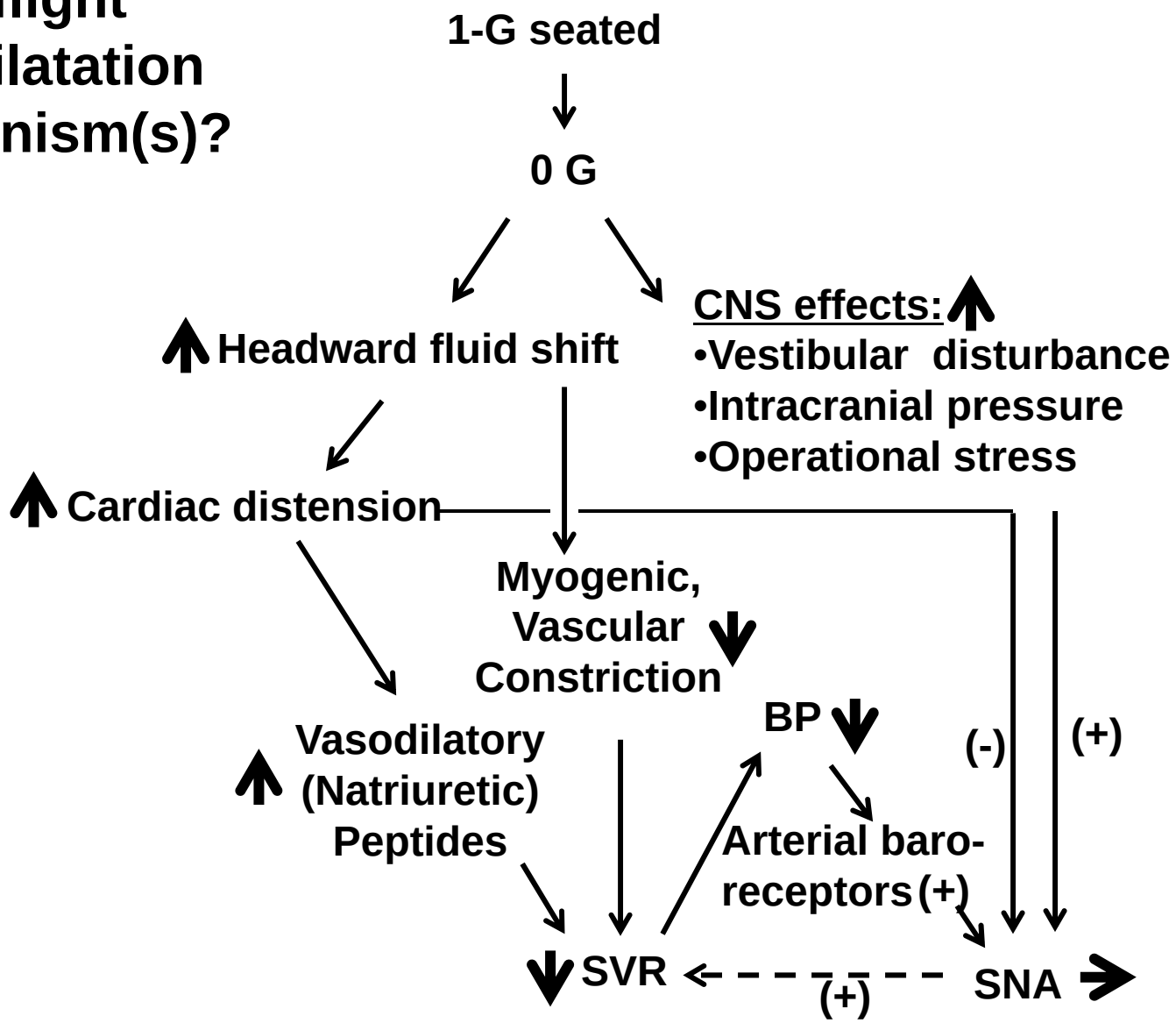


Spaceflight Vasodilatation Mechanism(s)?



Spaceflight Vasodilatation Mechanism(s)?